

Recently Major Beddome has found both land shells and reptiles with unmistakable Malabar affinities on the Golconda hills near Vizagapatam and Mahendragiri hill near Ganjam. On a former occasion, J. A. S. B., 1867, p. 199, I called attention to the peculiar isolation of *Rucervus Duvaucelli*, (the Barasingha deer,) *Gallus ferrugineus* and the Sáltree (*Shorea robusta*) just below Pachmari in the Denwa valley, but this is a case of an outlier of the Bengal fauna, not of that inhabiting Malabar. Mr. Hume (Scrap Book, I, p. 297,) records the occurrence of *Spizaëtus Nipalensis* on the Pachmari hills, and (J. A. S. B., 1870, p. 117,) of *Otocompsa fuscicaudata* on Mount Abú, and I have little doubt but that other Himalayan or Malabar forms accompany them.

NOTES ON TERRESTRIAL MOLLUSCA FROM THE NEIGHBOURHOOD OF MOULMEIN, (TENASSERIM PROVINCES), WITH DESCRIPTIONS OF NEW SPECIES,—by DR. F. STOLICZKA.

(With plates XV—XIX.)

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Fam. **Helicidæ.**

This family includes the stylommatophorous (stalk-eyed) species usually called *Helix*, and which do not possess a mucous gland at the upper termination of the foot. The jaws are usually ribbed, and the teeth shorter, and stouter, than in the ZONITIDÆ. I shall note two genera, *Plectopylis* and *Trachia*.

Genus. **PLECTOPYLIS**, Bens.

(See pl. xv, and its explanation.)

This name was proposed as a sub-genus of *Helix* in Ann. Mag. N. H., 3rd ser., vol. v, p. 244. Benson gave a description of the animal of *Pl. achatina*, (Ann. and Mag. N. H., 3rd ser., iv, p. 95), and pointed out (ibidem, vol. vi, p. 98) the characteristic differences of the shells, referred by him to *Plectopylis*, as compared with *Corilla*, (*Atopa* of Albers, *C. Rivolii* and others). The anatomy of the animal of *Plectopylis* indicates a good generic distinction from allied forms. I cannot, however, say how far the peculiarities, to which I shall presently refer, agree with the Ceylonese *Corilla*, but a

comparison of the two will no doubt prove interesting, and establish more firmly the relations of the present genus to *Corilla*, *Ophiogyra*, and the American *Polygyra*.

The Indian and Burmese species referable to *Plectopylis* are: *P. achatina*, Gray, *P. anguina*, *refuga* and *repercussa*, Gould, *cyclaspis*, *brachyplecta*, *plectostoma*, *leiophis*, *pinacis*, Bens., *Karenorum*, *perarcta*, *Andersoni* and *macromphalus*, Blf., a new species allied to the last from the Khasi hills, and probably also *Helix retifera*, Pfr., another species from Ceylon, and also *H. pettos** of Martens, apparently closely allied to *Pl. pinacis*. All the species characterize the Malay fauna; none of them occurs westward of Sikkim, and their geographical distribution extends from this part of the Himalayas, in a south-easterly direction through Assam, the Khasi and Tippera hills into Burma, Tavoy and the Southern Malay country. Only the last mentioned species is found on the Nilgiri hills, its form represents a slightly different type, the umbilicus being comparatively narrower than in any other *Plectopylis*, and the margins of the aperture are barely expanded; within there is only a transverse ridge on one side projecting between two pairs of tubercles on the other; no longitudinal ribs are present. I fully expect that, when the animal of *H. retifera* becomes known, it will probably exhibit somewhat different characters from those of the present genus.

The shells of *Plectopylis* are characterized by a planorboid, umbilicated form, somewhat expanded and usually thickened peristome, and by the presence of one or two transverse, and a few spiral ridges placed internally some distance from the aperture. I consider these internal folds to be in some respect analogous to the clausilium in *Clausilia*, the animals of the two genera being also somewhat similar in external characters. When the animal of *Plectopylis* retracts into its shell, the passage through the folds is generally found to be filled up with mucous secretion, but the body itself mostly retracts one half of a whorl further inwards. During hibernation the aperture is besides closed with the usual calcareous lamina, as in other HELICIDÆ.

I have examined the animals of *Pl. achatina*, *cyclaspis*, *pinacis*, and *macromphalus*. They are all very similar in external shape

* Malacozool. Blætter, xv, p. 158.

and organization. I will for the present note only the two first named species which occur near Moulmein.

In both the foot is rather short, rarely equalling in length the greater diameter of the shell, depressed, truncate in front, narrowly rounded or sometimes obtusely pointed posteriorly, covered with warts and granules; lateral line very slightly indicated, or not at all developed; body cylindrical, short, covered with rather strong warts; pedicles of moderate length, slightly thickened at the end, and with the eyes small, placed centrally or very nearly so; tentacles always very short. On the whole the form of the body very closely resembles that of a *Clausilia*, and a comparison of the internal organisation of the two genera also indicates their close relation.

The mantle margin is entire, thickened towards the end, but the edge itself is again thinner; pulmonary lobes simple without any appendages, the right larger than the left; pulmonary cavity very small, posteriorly closed up by a very thin lamina. The digestive organs are distinguished by the small size of the oral parts, great length of the stomach and of the intestines, which make a long double twist, but have no cæca or other appendages. The salivary glands are comparatively small. The liver very extensive and of a peculiar coarsely tubular, clustered appearance. The kidney is large, of triangular shape, and has a special duct at the anterior end; it terminates in the pulmonary cavity. Along the aorta there is either on the right, or on both sides, a linear gland of dark pigment (*pg*), its quantity, however, varying greatly in different specimens.

The genital organs are rather simple. The female part has two appendages: one longer which is the so-called *receptaculum seminis*, but in which I only found a light brown colouring matter intermixed with flat irregular particles, and a shorter, more muscular gland which appears to represent the arrow or amatorial gland. The uterus is thin, the hermaphrodite duct very long, and the hermaphrodite gland situated behind at the posterior end of the stomach. The vas deferens, or seminal duct, is short and thickened before it passes into the penis, which is attached by a strong muscle to the right median side of the mantle, but has no external appendages.

All the species which I examined are ovo-viviparous, as already noticed by Benson in *P. achatina*. One specimen of *P. cyclaspis* had three well developed embryos, each consisting of three convolutions, regularly coiled in and enclosed in a thin soft sac of calcareous granules, loosely jointed together. A specimen of *P. pinacis* had the whole uterus filled with 13 eggs, in different stages of development. The first were perfectly developed, composed of $2\frac{1}{2}$ whorls, distinctly discernible. The youngest only consisted of a yolk mass, darker internally than externally and folded on itself hemispherically, like an enrolled *Oniscus*.

The jaw is very thin, horny, semi-elliptical, with a small anterior median projection; it is marked transversely with a great number of more or less distant grooves which divaricate in the centre. The surface often besides shews in a transparent light a very fine concentric striation, either on the entire jaw, or only on its median portion.

The radula is long and of moderate width, composed of numerous (about 100, or slightly more) transverse, more or less angular rows, each containing between 60 and 70 teeth. The centre tooth is in *achatina* and *cyclaspis* very small, long, recurved and pointed at the end. The lateral teeth, which gradually decrease in size towards the outer margins, are of a subquadrangular shape; each possess a long rather obtuse, robust cusp, and besides that on the outer side an inflected margin with 2 or 3 small cusps, and on the inner a marginal cusp. The outermost teeth become quite simple in shape, only one or two of the outer denticles being indicated. On the last rows of the radula, the teeth have generally only the robust cusps developed.

On comparing the jaw of *Plectopylis* with that of *Clausilia*, it will be seen that both are similar in structure, but the shape is different and the transverse sulcations are only indicated in the latter genus. Much greater is the similarity of the *Plectopylis* jaw with that of *Cylindrella*, as published by Crosse and Fischer in Journ. de Conch., vol. x, 1870, p. 5, &c., pl. iii and iv, with the exception that the median projection is wanting in the *Cylindrella* jaw.

The arrangement of the teeth of *P. achatina* and *cyclaspis* also agrees with that of *Cylindrella* in the very small size of the centre

tooth, but this is not a constant character. In *P. pinacis*, the centre tooth is larger and more of a shape similar to that of the lateral teeth, which, however, in all the species retain distinctly the helicoid character.

PLECTOPYLIS ACHATINA, Gray, pl. xv, figs. 1—3.

Helix achatina, Gray apud Pfeiffer, Chem., &c. Hanley and Theob., Conch. Indica, pl. xiii, fig. 1.*

The two embryonal whorls are generally somewhat tumescent, very finely punctated or scrobiculate, and of a pale yellowish or whitish colour; the third whorl is pale rufescent with the striæ of growth distinct, in addition to which on the fourth whorl a spiral striation appears, but it soon again becomes obsolete, while the striæ of growth continue to be well marked.

Young shells are surrounded on the last whorl with three fringes of hairy cuticle, above and below, and near the centre of the whorl, which is conspicuously angular. The basal fringe at first, disappears, then the median, and at last the upper one.

The plication is one-third of the circuit of the last whorl distant from the aperture. It consists on the inner lip of one oblique transverse lamina, emitting at the base one short anterior fold, another near the middle, extending up to the centre of the inner peristome, at the upper end it is posteriorly bipartite, the lower branch bending downwards across the inner lip and terminating with a short rib directed backwards. At the base of the inner lip there is besides a separate very thin rib which becomes obsolete before it reaches the lower angle of the mouth. The outer lip has above three longitudinal ribs, the innermost of which is thinnest and the median posteriorly generally somewhat irregularly flexuous and bifurcate, a large transverse lamina projects into the triangular space formed by the inner lamina, and has a thin longitudinal rib below it.

This species is extremely common on all the limestone hills about Moulmein. Among thousands of specimens not one dextrorse variety was met with. The largest specimens I have seen mea-

* A very inadequate figure of the species. The last whorl is unnecessarily angular, the umbilicus too small, and the short fold at the basal angle of the aperture far too strong.

sured in the longer diameter 35 mm., but specimens of half the size, and even smaller than that, often have all the appearance of being full grown. The amount to which the aperture is deflected varies, but I never saw a specimen in which it was entirely turned downwards, as shewn in Küster's figure.

The usual colour is rufous brown above, albescent below, with the mouth deep or pale lilac about the peristome. In caves, secluded shady localities, and under large stones, white or yellowish white specimens are often found, the peristome being in this case also white. The colour of the animal varies as much as that of the shell; it is rarely white, more often grey or brownish black; in the former case the head, pedicles and tentacles and the foot in front are grey, in the latter these organs are only somewhat paler than the general dark coloration of the body.

PLECTOPYLIS CYCLASPIS, Bens., pl. xv, figs. 4—6.

Helix cyclaspis, Benson, vide Pfeiff. Mon. Hel., v, 414.—Hanley and Theob., Conch. Indica, pl. xiii, fig. 10.*

When the shells are well preserved and perfectly fresh they possess a coarsely serrated fringe of horny cuticle at the periphery of the last whorl; this fringe is, however, very easily worn off in older shells even during life. The two embryonal whorls are almost always yellowish albescent, the third is uniform brown, and the following become marbled and banded with white and brown. The spiral striation round the umbilicus, particularly alluded to in Benson's description of the species barely deserves the name; it is generally very indistinct and caused by the attachment of the fine hairs of the cuticle, this being there a little more strongly developed than on the rest of the lower surface, but the rugosity generally is hardly more apparent than on the upper side of the shell.

The internal plication is situated at a distance from the aperture of one-third of the last circuit. It consists on the inner lip of a large, transversely oblique, erect lamella, on the inner end produced into an anterior short fold; on the outer, or peripheral, side it is divided posteriorly into two folds, the outer of which

* An entirely insufficient illustration of the species;

is thin and extends directly backwards, while the inner proceeds obliquely across the lip, meeting a thin longitudinal rib, which runs on the inner side of the largest lamina, so as to include a kind of a triangular space. In this space there projects from the basal side of the whorl a large oblique transverse lamina, accompanied on either side by a thin longitudinal rib. Two thin ribs are situated on the upper side of the whorl between the suture and the peripheral keel. The median rib which originates near the edge of the inner lip of the aperture extends only for a short distance internally. The plication, as above described, was observed to be constant in 8 specimens of various sizes.

Judging from the description of Pfeiffer's *H. revoluta* (Mon. Hel., v, 416) I can hardly think that the shell referred to can be distinct from *cyclaspis*. I have specimens of this last which perfectly agree with the measurements given by Pfeiffer of his *revoluta*, and said to be from the Andamans. I never received *cyclaspis* amongst many thousands of shells from those islands, and I doubt its occurrence there quite as much as that of *P. achatina*, recorded by Tryon, (comp. Proc. Asiat. Soc., March, 1870, p. 88). The shell fauna of the Andamans and Nicobars shews considerable relations to that of Arracan, but barely any to that of the limestone hills about Moulmein. The latter is, as already stated, quite peculiar, and very distinct from the fauna of the adjoining low lands, and even from that of the neighbouring sandstone hills.

P. cyclaspis is found sparingly on all the limestone hills about Moulmein. The animal is very shy, usually living in crevices and holes, and closely adhering to the rock even when moving about. It is uniform dark grey or blackish with a pink tinge, paler on the pedicles and tentacles, the latter being very small and situated quite at the base of the mouth; the warts of the body are black and rather large.

Genus. TRACHIA, Albers.

(See pl. xvi, figs. 1—3, and the accompanying explanation.)

This genus was proposed by Albers for *H. asperella*, Pfr., as type. It is characterised by a planorboid shape, moderately thin semi-transparent structure of the shell, covered with a setaceous cuticle, by

an expanded outer peristome and by usually possessing a spacious umbilicus. Albers places in the genus also *H. Tuckeri*, Pfr., *fallaciosa*, Pfr., *ruginosa*, Fér., and *nilagirica*, Pfr. Of these only the first is probably referable to the genus, the others I would prefer classifying in *Planospira*, considering *nilagirica* as the most aberrant form. Mr. W. T. Blanford (Ann. Mag. N. H., 1863, 3rd ser., vol. xi, p. 85) added to the genus* *H. delibrata*, Bens., *gabata*, Gould, (= *Merguensis*, Pfr.), *Helferi*, Bens., *vittata*† Mill., *proxima*, Fér., and *crassicostata*, Pfr. The three last named species have, I believe, again to be referred to *Planospira*, but the three others participate of the generic characters of *asperella* and must, therefore, be considered as belonging to *Trachia*. I could quote a few other species, as for instance *H. squalus*, Hinds, *H. mendax*, Martens, and others, but they do not strictly speaking belong to the Indo-Burmese fauna.

Planospira of Beck differs from *Trachia* by the solidity of the shell, thickened inner lip, &c. *Campylæa* is, however, much more closely allied to *Trachia*, both in form and structure of the shell; indeed there are strictly speaking no external characters to distinguish the two. But the former, with its type *H. cingulata*, is said to possess a 4—6 ribbed jaw, and the genital organs have numerous appendages, while in *H. delibrata*, (the only species of *Trachia* of which I have examined the animal), the jaw has a great number of ribs and the genital organs are of a very simple form. Should, however, these characters prove to be of no avail for purposes of classification, the two genera must be united into one, and this is by no means improbable.

The structure of the shell of *Trachia* also exhibits considerable relation to some of the species of *Dorcasia*, and *Fruticicola*, the latter apparently represented in India by the *Helix similaris* group. I have examined some animals of this species from Penang, and I find that the dentition agrees, but the jaw and genital organs are different from those of *Trachia*; the former being generally costate, and the latter with a thick amatorial gland.

It is difficult to predict in the present stage of our knowledge of the animals what extent should be given to the genera *Dorcasia*

* Quoted by a misprint as '*Tachia*.'

† I agree with Mr. Blanford that there is no need of proposing a new genus for this species, as has been done by Albers.

and *Fruticicola*, if *H. similaris* and *bolus*, and others, are to be considered as belonging to the latter. These species evidently pass gradually through *H. tapeina*, Bs., *Huttoni*, Pfr., *H. Oldhami*, Bs., to the more acutely carinated species, as *Osbecki*, Phil., *trichotropis* and *elegantissima*, Pfr., for the last of which Albers proposed the name *Plectotropis*. *H. gabata* was incorrectly referred by Albers to the latter genus, while the closely allied species, *H. delibrata*, is referred by him to *Planospira*. Albers places *H. rotatoria* in his new genus *Discus*, (a name which cannot be used), and refers it to the ZONITIDÆ. The type of his *Discus* is *H. Metcalfi*, Pfr., which is most likely a *Trochomorpha*, a genus to be placed at the end of the ZONITIDÆ, being in many respects intermediate between this family and the HELICIDÆ. Mr. Blanford's *Sivella*, proposed for *H. castra*, Bens., is also to be united with *Trochomorpha*. The animal has an undivided sole to the foot, but a very faint mucous groove at its upper posterior end.

H. Huttoni is found in Albers' list among the *Rotulæ*, and there are a great number of other similar misplacements in that author's lists regarding the Indian and Malayan HELICEA; some of the more evident mistakes have already been pointed out by Mr. W. T. Blanford in his numerous conchological papers.

TRACHIA DELIBRATA, Bens., pl. xvi, figs. 1—3.

Helix delibrata, Benson, Journ. A. S. Bengal, 1836, vol. v, p. 352; *eadem* Pfeiff, Chem., Phil., Reeve, &c. Hanley and Theob., Conch. Indica, pl. xiv, fig. 4, (*H. gabata*), and figs. 9—10.

The form described from Tavoy by Gould as *H. procumbens* (Bost. J., 1844, vol. iv, p. 453, pl. xxiv, fig 1), represents a peculiar variety, which is figured by Reeve, while Chemnitz' figure is most probably taken from a Khasi hill specimen. The Tavoy form which also occurs at Moulmein, (though rather rarely), has the whorls rapidly increasing, the spire flat or very little elevated, the last whorl considerably descending and the inner lip very narrow, giving, so to say, a trumpet shape to the aperture. The usual size is 18—20 m.m. The surface is covered with a pale olivaceous or brownish cuticle, distinctly hairy in young specimens, but becoming almost perfectly smooth and shining in older ones;

at the upper periphery of the last whorl there is usually a single brown band traceable. Specimens devoid of the cuticle appear white; one of this kind was figured by Hanley and Theobald under the name *H. gabata*, as already alluded to.

Specimens from Pegu and Upper Burma, perfectly agree with those from Moulmein, except that the aperture is generally a little less deflexed. Large specimens, measuring in the longer diameter more than 20 m.m., often become very flat.

Specimens from Assam (Tézpore) have the whorls more regularly increasing, than Burmese specimens, they possess, therefore, a more orbicular shape, and the upper side is conspicuously convex. The cuticle becomes quite smooth with advanced age, and the shells are often encircled with numerous broader and narrower reddish brown bands. Full grown specimens (22—25 m.m.) from the Khasi hills and from Darjeeling appear to be peculiarly thin, and when well preserved they have the cuticle very rough and hairy; they are also generally marked with numerous brownish bands. In all specimens from the three last named localities the aperture is much less deflected and the inner lip longer, than in those from Tenasserim and Pegu, thus giving the shell apparently a very different aspect from the southern *procumbens*, but the gradual change from one form into the other, as well as the variations to be noticed in one and the same locality, clearly shew that all belong to one and the same species; at least there is not one constant character by which they could be separated. The following measurements exhibit the amount of variation.

	Moulmein.	Pegu.	Assam.		Khasi hills.	Darjeeling.
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>
Larger diam. (including expansion of lip),	18·5	23·0	18·0—18·5		23·0	21·5
Width of last whorl near the aperture, ..	6·5	7·8	6·6—5·5		8·0	8·0
Smaller diameter,	14·0	18·3	14·3—15·2		17·7	16·5
Height of shell,	9·3	10·2	9·0—10·0		9·3	9·5
" of aperture,	7·4	9·5	8·2—8·5		8·5	8·5
Width,	9·3	12·0	9·8—9·0		11·5	11·0
Smaller diam. : larger diam.	0·75	0·79	0·79—0·82		0·79	0·76
Height of aperture : width, ...	0·79	0·79	0·83—0·94		0·74	0·77

procum- *procum-* *delibrata.*
bens, *bens,*

a typical; *b*, approaching the type.

The two last items in the table, giving the relative proportions of the most important characters upon which the growth of the shell depends, clearly shew the identity of the species. Two forms geographically most distant, from Moulmein and Darjeeling, very closely correspond with each other. The limits of variation in the proportions between the smaller and the larger diameters are 0.75 and 0.82, and those of the height to width of the aperture 0.74 to 0.94, the difference being chiefly due to the greater or lesser expansion of the peristome.

The animal of the Moulmein variety is fleshy grey, anteriorly much longer than posteriorly; foot depressed, finely granulated like the rest of the body, without a lateral line; pedicles long, tentacles moderate, both of a darker grey colour; a pale strip runs from between the pedicles along the centre of the back and gradually disappears posteriorly.

The mantle is entire at its edge and very slightly thickened, internally spotted with dusky brown; the left dorsal lobe is only represented by a simple thickening, the right reaches anteriorly over the back and becomes rapidly narrower below. The mouth is short, thick, as in other *HELICIDÆ*; the salivary glands very large, enveloping the whole of the anterior part of the alimentary canal. The intestines are of considerable length, making one shorter and one longer twist. Other parts of the digestive and secretory systems do not differ from those of other *HELICIDÆ*; but the genital organs are peculiar. The uterus is thin and long; the seminal receptacle almost equal to it in length, and only moderately thickened towards its obtuse end. No glands at the anterior end of the uterus, nor an appendage on the recept. seminis; neither was an arrow gland observed. The penis is, however, very long, twisted, with a small cœcum (? flagellum) at the point where the vas deferens enters; the last thickened part is suspended by a special retractile muscle.

The jaw is moderately narrow, semilunar, ribbed on the entire surface, the 7 median ribs being stronger than those following at the sides.

The radula is of very great length. I counted 124 transverse, slightly angular series of teeth. The median tooth is very little

smaller than the adjoining; it is obtusely pointed, with a small emargination on either side. The following teeth are gradually more oblique, but the base retains its subquadrangular shape; the inner large hook decreases and the outer small pointed one increases in size, until they become nearly equal. The one or two outermost teeth appear to be shortly tricuspid. The basal portion of the teeth is in all elongately subquadrangular, above very slightly emarginate on the central tooth, but becoming gradually more so on the laterals, while at the same time the width slightly and the length considerably decrease, until on the last teeth the upper ends are very distinctly bifurcate. The formula of the teeth is 22 (to 18) + 20 — 1 — 20 + (18 to) 22, there being 77 to 88 teeth in each transverse series. The first 20 teeth on either side of the central tooth are somewhat larger than the following, but the passage from the larger to the smaller ones is very gradual, and not always distinctly traceable.

TRACHIA GABATA, Gould.

Helix gabata, Gould, 1844, Bost. Journ., vol. iv, p. 454, pl. xxiv, fig. 9;—*eadem* Chem., Pfeiff., Reeve, &c.

Hanley and Theob., Conch. Indica, pl. xiv, fig. 7, non *H. gabata*, *ibidem* fig. 4 = *H. procumbens*, Gould.

H. Merquiensis, Phil., 1846; *eadem* Pfeiffer, et auctorum.

Plectotropis gabata, apud Wall., Proc. Z. Soc., 1865, p. 408.

The specific distinctions pointed out by Philippi between his *Merquiensis* and Gould's *gabata*, and relied on by subsequent authors, do not exist in reality. Both forms are covered with a hairy cuticle, but, when the hairs are broken off, a finely granular, or rather punctate or scrobiculate, surface is produced, which generally can be easily detected, if not on the whole, at least on some portions, of the shell. Rarely are the hairs so much worn down, that the surface attains the appearance of being quite smooth.

Shells which have the upper side quite flat, resembling the one figured by Gould, would seem to be of extreme rarity. I have not seen any full grown ones equal to it, but specimens with a slight upper convexity, like those delineated by Chemnitz and Reeve, are of common occurrence. The upper convexity of the shell is indeed subject to considerable variation. Some specimens have

the whorls above so very tumid, that the peripheral keel on the last whorl instead of being near the upper edge comes to be situated nearly in the middle of the whorl. The aperture is more or less deflected, of a transverse, elongately oval, shape, with the inner lip generally conspicuously thickened and slightly emarginated.

The species was originally described from Tavoy. It is not uncommon about Moulmein on the limestone hills at Damotha and eastward on the Gayín river, but I have not obtained a living specimen of it. Major Godwin-Austen collected it also in the North Cachar hills. Wallace quotes it (doubtfully) from Celebes, but Martens, (Preuss. Exped., p. 391) seems to question the correctness of the locality.

Hanley and Theobald, in their Conch. Indica, give a rather poor figure of *Merguiensis*, but what is figured as *gabata*, Gould, appears to me to represent a shell of exactly the same type as Gould's *procumbens* which is identical with Benson's *delibrata*.

Fam. ZONITIDÆ.

The animals of this family are characterized by the invariable presence of a mucous gland, situated at the truncate, posterior end of the foot; above the base of the sole runs a distinct lateral line, or a row of enlarged tubercles, between the gland and the mouth; the jaw is smooth, or finely concentrically striated; outer teeth of the radula slender and generally bicuspid at the end, except the very last ones which are often simple, styli-form.

In the muscular, digestive and nervous systems the ZONITIDÆ do not differ from the HELICIDÆ, but there is usually a slight difference to be observed in the reproductive organs. In the latter family the so-called arrow or amatorial sac* (glandula mucosa cum sagitta amatoria) is short, with numerous thin appendages; in the former it is either simple, or sometimes altogether absent. If present, it appears to be an important organ during copulation. It is generally of a cylindrical shape and of a tough, muscular structure, attached by a special retractile muscle, enclosed in a tubular sheath and terminating with a pointed papilla or flagel-

* Or dart-sac of some English authors.

lum. The internal cavity is often filled with hardened particles of various shapes. Although during copulation an intromissile organ, it can only be considered as an organ of irritation, while the true penis is represented by a simple enlarged tube of the terminal part of the seminal duct (vas deferens). This is mostly the case, whenever the amatorial sac with its papilla is well developed. Some most remarkable organs, apparently modifications of the amatorial sac will be noticed in the genus *Sesara* and in *Macrochlamys* [*Durgella*] *honesta*. I hope to return to this subject at some future date and give a revised list of the Indian genera belonging to the present family, but many more animals must yet be examined, before reliable materials for purposes of classification can be obtained.

For the present I shall confine my remarks to the following genera, *Rotula*, *Conulema*, *Sesara*, *Macrochlamys* with *Durgella*, *Microcystis* and *Sophina*. Of other forms of ZONITIDÆ, common about Moulmein, I have omitted *Helicarion*, having the intention of examining this genus in connection with several other allied forms from the Khasi-hills and from the Himalayas at an early date.

With reference to the organs which are useful in the grouping of the ZONITIDÆ, I would especially draw attention to some variabilities in the genital apparatus. The presence or absence of an arrow, or amatorial sac, has been considered as an important generic distinction. I have repeatedly satisfied myself, that it is not so, and moreover that references to the form and shape of the genital organs must be very cautiously made. When animals are examined, it is very important to know whether they are full grown or adolescent, or very young. In each of these cases the form of the genital organs may be very different, as will, for instance, be found noticed in the genus *Sesara*. Again the size and development of certain parts of the genital system vary greatly according to the season of the year, &c.

In speaking of the different organs in the general anatomy of the animals, I have mostly employed terms which have come into general use in anatomical publications. The arrow sac, (or dart-sac of some English authors) I have often termed amatorial sac, be-

cause it includes only an amatorial, not a true copulative, organ. When speaking of the mantle (see pl. xvii, fig 2,) I have termed, according to Semper, the two portions of the mantle, which on either side of the pulmonary opening are more or less reflected over portions of the peristome, the right and left *shell-lobes*, and those which cover the back of the animal the *dorsal-lobes*. Strictly speaking, there are only two mantle lobes present, one right and one left, but of each the superior portions often cover parts of the shell, and these are called *shell-lobes*; they besides often possess separate appendages.

The foot is below either grooved in the middle or not, but there is always a more or less wide muscular area present, which is separated from the margins of the sole by fine lines.

Genus. ROTULA, Albers.

This name was proposed by Albers (*Helic.*, edit. 2nd, p. 62,) for *Helix detecta*, Fer., which species represents a type of *subdiscoid* ZONITIDÆ, possessing a thin shell with numerous whorls, these being narrow, flattened and sculptured above: the last with more or less inflated, smooth, or finely striated polished base; narrowly, or not, perforated; carinated at the periphery; apertural margins simple, attenuated, sometimes internally slightly thickened. Thus characterized *Rotula* would include a large group of ZONITIDÆ from India and the adjacent islands. I may mention *serrula* and *pansa*, Bens., *indica* and *Shiplayi*, Pf., *Kundaensis*, Blf., &c. When the last whorl is more rounded, as in *ornatissima*, Bens., the form would appear to pass into Semper's *Euplecta*, and when the upper sculptured surface becomes smoother, as in *textrina*, Bens., the shells would appear to form a transition towards *Macrochlamys*.

If the external characters of the shells be alone consulted, I do not think that great difficulty can be experienced in classifying the species under this genus, and, unless disproved by the examination of the animal of the type, *R. detecta*, Fér., the genus may stand as indicated above. If this be admitted, and considering *Helix anceps* of Gould, *H. Massoni*, Behn, and another unnamed species from Penang,—of all of which I have examined live animals,—as belonging to *Rotula*, I may add the following

from the soft parts of the animal to the characteristic of the genus.

Foot about equal in length to twice the largest diameter of the shell, moderately narrow, tail gland distinct with a small, obtuse, hook-like appendage above it; sole with two longitudinal furrows; left shell-lobe with a narrow appendage, originating some distance from the pulmonary orifice, a little below the angular periphery of the last whorl of the shell, and reflected over the basal portion of the last whorl only; right shell-lobe linguatate, above (at the posterior angle of the aperture of the shell) thickened, and below (at the columellar lip) slightly produced; left dorsal lobe divided into two lobes, the upper linguatate, the lower narrow, sometimes nearly obsolete; right dorsal lobe large, considerably extending over the neck of the animal. Jaw semilunar, of nearly equal breadth throughout, smooth; radula with many median rows of subequal teeth conspicuously larger than the outer teeth.

It will be seen from this characteristic that I omit to make reference to the form of the genital organs for reasons which I have already explained, but further on I shall give some anatomical details of a species which, I believe, may be considered as one of the typical forms of the genus, *R. anceps*.

Semper (Reisen im Arch. der Philipp., vol. III, pt. i, p. 38) characterizes *Rotula* merely from a few anatomical characters which appear to me very insufficient for such a purpose. He considers Albers type as only doubtfully belonging to the genus, thus establishing the latter altogether upon a new basis, and placing *H. calatura*, Fcr., *rufa*, Lesson, *Massoni*, Behn, and *Campbelli*, Gray, in it. Of these I would exclude the first named species; the form of its shell is quite different from those of the other species, and the character of ornamentation indicates that the mantle lobes, if any be present, must also be different; it besides has no appendage above the tail-gland. The three other species I take, however, to belong to *Rotula*.

H. semicerina, Morl., (= *Rawsonis*, Reeve) is also referable to *Rotula*; it is connected through *implicata*,* Nevill, with *H. argentea*, Reeve, and thus passes into the *Trochomorpha* type of shell, though the animal is decidedly one of the ZONITIDÆ. *H. cernica*,

* Journ. Asiat. Soc., 1870, vol. XXXIX, pl. ii, p. 407.

Ad., *imperfecta*, Desh., *mucronata*, Reeve, appear to represent quite a different group of ZONITIDÆ with almost membranaceous shells. The South Indian *H. ampulla* probably belongs to this group. The shells are somewhat allied to the new genus *Conulema* (type *H. attega*, Bens.), but the whorls are fewer and rapidly increasing. Their closest ally will probably be *Helicarion*, but an examination of the animals is necessary in order to determine the extent of the group.

I expect that several species of Albers' *Thalassia*, which chiefly includes Australian shells, will also be referable to *Rotula*, but I am not quite certain that Semper's *Euplecta* is sufficiently distinct from the typical forms of *Thalassia*.

ROTULA ANCEPS, Gould, pl. xvii, figs. 1—3.

Helix anceps, Gould, 1844, Bost. Journ., IV, p. 454, pl. xxiv, fig. 4; *eadem* Chem., Pfeiff., Reeve, &c., (? = *Nanina arata*, Blf.).

Chemnitz's figure of the species is excellent, but somewhat flatter forms also occur. The fresh shell is thin and transparent, covered with a shining epidermis; the striæ of growth are above strongly marked, crossed by fine spiral lines, the base is polished and with hardly traceable striæ of growth.

I found the species common to the south of Moulmein and near Amherst on trees and bushes in damp localities. At Damotha I obtained only four dead specimens on a limestone rock; they have distinctly a more solid shell, but do not differ in any other respect from those found on trees.

Typical specimens of Blanford's *N. arata* from Upper Burma (Proc. Zool. Soc. 1869, p. 448), differ by having the base of the last whorl less inflated and somewhat more distinctly striated, but the differences are such, as may easily be referred only to a local variation of *anceps*, the shell being larger and flatter.

The animal is dark grey with a distinct greenish tinge, darker on the front part of the head and on the pedicles. Foot long, slightly more than twice the longer diameter of the shell; lateral line distinct, rather high up above the edge of the sole; the portion of the foot above the line is obliquely furrowed, below it nearly smooth, or very finely striated. Posterior part of foot

tapering, obtusely truncate at the end; tail-gland with slightly thickened edges and a small hook-like appendage above. Sole of foot with two longitudinal, not very distinct, furrows; its middle part is a little broader than the lateral parts.

The outer mantle edge is slightly thickened. The left shell-lobe (*lsl*, in fig. 2) has below the angular periphery a linguatous process, reflected over the basal part of the peristome, and ends with another shorter appendage near the shell retractor; the right shell-lobe (*rsl*.) has a linguatous process at the posterior angle of the mouth, and another broader one covering the columellar lip. The left dorsal lobe (*ldl*.) consists of a small linguatous process next to the pulmonary opening and extends after a short interruption as an indistinct rim (in young specimens obsolete) along the inner side of the mantle. The right dorsal lobe (*rdl*.) is considerably produced over the neck and recedes rapidly, barely reaching to the shell retractor.

The pulmonary cavity is spacious, with dark pigment arranged in some irregular transverse bands. The pigment is supplied from a long, blackish mass spread superficially over a white, albuminous gland (*pg*, in fig. 1), accompanying the dull yellowish kidney, next to which on the left side follows the heart (*h*). The mouth is large, fleshy; the salivary glands also large, on long strings and in the original position situated at the lower anterior end of the stomach; the latter is about $1\frac{1}{2}$ volutions long, without any cœcal appendages; the intestines form only one twist and are surrounded by two lobes of the liver. A narrow albuminous gland (*ag*) accompanies the rectum.

The liver consists of several lobes: one is situated next to the hermaphrodite gland, while two others envelope the intestines; a fourth larger lobe begins at the lower end of the kidney and covers nearly the whole of the lower side of the stomach; the last $2\frac{1}{2}$ volutions are also occupied by the liver.

The nervous system with its numerous branches does not differ in any essential particular from that of other ZONITIDÆ.

The genital organs occupy the right side of the dorsal cavity. In full grown specimens they are very complicated. The arrow sac (*ag*) is very thick, twisted, angularly bent near the anterior

end, and internally provided with a strong, pointed papilla. This is composed of three entirely different layers of muscular tissue : the outer one consists of tough longitudinal muscles, the next is a thick layer of transverse muscles, and then follows a soft tissue in which longitudinal muscles prevail ; the inner cavity is in its entire length filled with an extremely fine granular substance, the granules being opaque and nearly equal in size. The hermaphrodite organ begins as a simple tube, the seminal receptacle branching off some distance from the opening, its end lies imbedded in soft tissue at the anterior part of the uterus. Where the seminal receptacle branches off the prostata possesses a small, dark, sessile, muscular appendage (*fa*). The inside of this resembled (in spirit specimens) a soft mass of fine reticulated threads, like spermatozoa. The *vas deferens* has about the middle a long appendage (*fl.*) which enclosed a very thin, elastic or spongy flagellum ;* after this the duct thickens into a gland, filled with white, ovately lenticular, calcareous particles, having the appearance of a milky substance, when that gland is cut upon. A short distance from the calciferous gland follows again a cœcal appendage, attached by a few muscular threads to the inner side of the mantle ; the terminal portion of the duct represents the true penis, it is somewhat bent and thickened near the middle, but it does not enclose a specially developed papilla for purposes of copulation.

One young specimen which I examined did not appear to have the amatorial sac developed, at least I was not able to trace it. The uterus was very thin ; the receptaculum seminis represented by only a very thin tube, twisted round the anterior part of the former. The *vas deferens* had a small flagellar appendage (*fl.*), but the flagellum itself could not be traced, and there were no calcareous bodies developed in the small enlargement of the duct next to the flagellar appendage.

The jaw (fig. 4) is rather narrowly semilunar, smooth, very slightly prominent at the median part of the concave front edge. In transparent light there is on it a very fine, somewhat irregular concentric striation perceptible, particularly near the front edge.

* This flagellum is entirely distinct from the sac with calcareous bodies, and appears to have the object of assisting the passage of the spermatozoa through the calcareous mass which fills the enlargement next to it.

The radula has about 75, almost straight, transverse, closely set rows of teeth, there being about 135 teeth in each row, (fig. 5). The median 25* teeth are subequal among themselves, but considerably larger than the outer ones, (about 55) on each side. The centre tooth is symmetrical, tricuspid, with the median point most prolonged, the lateral cusps being comparatively small and turned somewhat outwards and inwards; the following teeth twist more and more outwardly on either side, the large, strongly curved, points becoming always thinner and the outer lateral points slightly larger, until they nearly equal each other in size. At the same time the breadth of the teeth considerably decreases.

Conulema, n. gen.

(Type, *Helix attegia*, Benson, from Burma.)

Shell conoidal, thin, consisting of many, usually spirally ribbed or striated whorls; base convex, narrowly or indistinctly umbilicated; margin of the aperture thin, not expanded; outer simple.

Animal narrow, long, (generally equal to twice the greater diameter of the shell); pedicles long, tentacles much shorter, lateral line distinct, the margin below it smooth; gland at the end of foot large, superseded by a distinct horn; sole grooved; two shell and two dorsal-lobes to the mantle, all of them small and with no separately produced appendages, but slightly extended on either end; genital organs with, or without, an amatorial gland; a single appendage to the penis, produced into the penis retractor; receptaculum seminis terminating with a bulging end, attached to the anterior portion of the prostata. Jaw thin, transparent, smooth indistinctly or finely concentrically striated in the middle. Radula large, consisting of numerous (about 100) transverse rows, each with very numerous (300 to above 400) teeth, a few median teeth being conspicuously larger than the laterals which are narrow, pectiniform and very gradually decreasing in width.

Following E. v. Martens, Mr. W. T. Blanford referred the type species of this genus, with several other allied species, to Albers' *Trochomorpha*, but I have already (p. 225) noticed, that this name must be retained for an entirely distinct group, the type of which is *Tr. planorbis*, Lesson.

* In younger specimens somewhat less.

The Indo-Malayan species which have presently to be referred to *Conulema* are *Helix attegia*, (with *culmen*, Blf.), *infula*, *cacuminifera*, *arx* and *palmira*, Benson, *H. gratulator* and *confinis*, Blf., *Con. liri-cincta*, n. sp., and probably also *Nanina apicata*, Blf. and *H. hyphasma*, Pfr., from South India and Ceylon, *H. leucophlewa*, Martens, from Celebes, and a few others.

The genus is, as regards form and structure of the shell, closely allied to Semper's *Martensia** (Reisen im Archipel der Phil. &c., 2ter Theil, ivter Band, p. 42), but in this the right shell-lobe of the mantle is said to be entirely absent and the penis has two cœcal appendages, which have not been observed in *Conulema*. The presence or absence of an amatorial gland cannot be accepted as a generic character, which will be evident from what I shall presently say in comparing the generative organs of *C. attegia* with those of *C. infula*.

For Hutton's *Helix fastigiata* which may be identical with Pfeiffer's *Helix Barakpoorensis*, and *H. aspirans*, W. and H. Blf., Mr. W. T. Blanford proposed the name *Kaliella* (Ann. and Mag. Nat. Hist., Feb. 1863, vol. xi, p. 83). The anatomy of *H. Barakpoorensis* closely resembles that of *Conulema*, but the dentition is different, that species having fewer teeth in a transverse row and a great number of the median ones enlarged, all being squarish, not pectiniform.

CONULEMA ATTEGIA, Bens., pl. xviii, figs. 1—4.

Helix attegia, Benson, Ann. and Mag. Nat. Hist., 1859, vol. iv, p. 184, —*eadem* auctorum.

Nanina culmen, Blf., Journ. Asiat. Soc Bengal, 1865, xxxiv, pt. 2, p. 72.

The animal is of a dull whitish colour ; the larger warts of the body, often possessing a pink tinge, are arranged in oblique rows ; the pedicles are grey, and this colour also extends over a part of the back ; ridge of the posterior part of the foot ashy grey ; mantle lobes light, or sometimes pinkish-grey ; inner part of mantle, forming the pulmonary sac, with spots and stripes of dark pigment, giving the shell, when the animal is retracted, a spotted appearance.

The mantle lobes are very slightly extensible. Those covering the shell are somewhat thickened near their margins, the left shell

* This name has already been employed in Botany.

lobe being slightly reflected over the edge of the outer lip, so as just to cover it. The right dorsal lobe is much larger than the left, which is represented by a mere thickened rim.

The general anatomy of the digestive and nervous organs and of the muscular system is exactly as in *Rotula*. The generative organs have a large and long uterus; the terminal swollen end of the seminal receptacle is imbedded in a soft tissue at the anterior end of the prostata; vas deferens short and extremely thin, widened before it enters the penis, the expanded portion being filled with a granular colouring pigment, in which, however, no calcareous particles were discernible. The penis is rather thick, posteriorly prolonged and attached by a thin muscle to near the end of the prostata. The amatorial gland is a very strong, tough, twisted tube, enclosing a pointed flagellum. A section of the median portion of the gland (see 1a on pl. xviii,) shews an external thick layer of longitudinal muscles, (α) then follows a layer of transverse muscles (β), and after this a thinner, but very tough layer (γ), enclosing a hollow space (δ), which in spirit specimens was filled with a jelly-like substance, mixed with harder flattened bodies of an irregular shape.

The jaw is semicircular, slightly projecting in the centre of the concave edge, smooth, about the median part indistinctly and very finely concentrically striated; the posterior part, along the convex edge and some distance from it, is not perfectly solidified.

The radula is very large, consisting of about 100, nearly straight or slightly undulating transverse rows. In a full grown specimen I counted 405 teeth in each row, the formula being $200 + 2 - 1 - 2 + 200$, and the total number of teeth about 40,000. The four median teeth are conspicuously larger, than those following on either side, all have a sharp pointed cusp at the anterior end. The centre tooth has besides two smaller cusps at each side and is symmetrical; the following are gradually more and more turned on either the right or left side, and the smaller cusps are, therefore, developed only on one side; the last lateral tooth is styliform.

The shell of *Conulema attegaia* is subject to a large amount of variation. The original specimen described from Tenasserim

was a thin horny shell, and probably not quite mature. Young shells have the periphery always very sharply carinated, and the spiral ribs or striæ on the whorls, as well as on the somewhat inflated base, are distinct. Specimens which live on foliage, or other kind of vegetation in low land, retain the thin horny structure of their shells, even when full grown, but the spiral striation of the whorls is often difficult to be traced. On drier places and on sandstone hills the shells become more solid and are covered with a thin horny cuticle; the spiral striation becomes very distinctly discernible, and there often appear intermediate striæ between the 4 or 5 stronger spiral ribs. A young specimen of this type has been described by Blanford as *Nanina culmen*. On limestone ground the shells become again more solid, often attaining a considerable thickness, and the specimens also grow to a larger size, but the spiral striation occasionally disappears almost entirely on the two last whorls.

The species is common about Moulmein, though not so much on low land as on limestone hills. The spiral angle of specimens collected in Burma varies from nearly 70° to 86 degrees. The following table will indicate some of the principal variations.

	Pegu.		Moulmein.		
Number of whorls,.....	6	8	6½	6½	7
Larger diameter,	5·8	13	7·	8·	11·2 mm.
Shorter diameter,	5·2	11·5	6·4	7·2	10· "
Height of shell,.....	5·5	12·	7·	7·5	10· "
Spiral angle,	72°	80°	70°	80°	86° "
	} <i>culmen. attegia.</i>		} <i>attegia.</i>		

CONULEMA INFULA, Bens., pl. xviii, figs. 5—9.

Helix infula, Benson, Ann. and Mag. N. Hist., II, p. 160,—*eadem* auctorum.

The animal of this species is identical in form and coloration with that of *attegia*, except that there is often a little more leaden grey on the upper posterior part of the foot, tinging the sole. The general organisation is also the same in both, with the only difference that in the genital organs the amatorial sac is entirely absent. The end of the seminal receptacle is attached by a fine thread to the anterior part of the prostata, and the albuminous gland of the uterus is comparatively larger than in *attegia*.

In specimens which I examined in winter the oviduct was anteriorly only slightly enlarged, but all larger specimens examined during the rainy season shewed a very conspicuous orange coloured swelling in that place (*ov*, in fig. 7, on pl. xviii). The ova composing it were in an advanced state of development, and some of them shewed already a spiral arrangement of dark corpuscles.

The jaw exhibits a rather distinct but very fine concentric striation, the median projection in the anterior concavity is very slight, and the convex edge is partially soft, granular, not entirely horny.

The radula is large, composed of about 100, nearly straight, transverse rows, each generally consisting of from 307 to 321 teeth, the seven median teeth being conspicuously larger than those following on either side, the formula being $150 + 3 - 1 - 3 + 150$; and the total number of teeth is somewhat above 30,000.

The anatomy of the present species, when compared with that of the last, agrees, as already stated, almost perfectly. There is a slight difference in the terminal attachment of the seminal receptacle and in the number of enlarged teeth, but the only essential distinction lies in the absence of an amatorial sac in *infula*. I was at first inclined to attribute the absence of that organ to immaturity, but this view was not supported by the examination of specimens at all seasons of the year, and some which had fully developed ova. The only conclusion I can arrive at is, that the presence or absence of an amatorial sac cannot be considered as a character of generic importance, for it would be simply dragging classification into absurdity, if we would refer *infula* and *attega* to two genera, while almost every other point of organisation, the form and colour of the animals and of the shells, are nearly perfectly the same.

C. infula is a common* species in the neighbourhood of Calcutta; it occurs sparingly in Western Bengal and northwards up to the foot of the hills, and is also found near Poona and Balarampúr in Southern India. In none of these localities do the specimens attain the size of the Burmese *attega*, and when compared with ordinary

* A few years ago it was almost only seen in Orchid houses, but now it appears to become more generally distributed.

specimens of the latter, the spiral angle is generally found to be smaller, the whorls slightly more convex and the base of the last less inflated. However, these characters are all somewhat variable, and I collected specimens of *attegia* at Moulmein which are almost undistinguishable from the Bengal *infula*, the only difference being that the former are clearly immature, while the latter of the same size have all the appearance of full grown shells.

The following measurements have been taken from specimens of different localities.

	Calcutta.	Raniganj.	Poona.
Number of whorls,	6½	7	5½
Larger diameter,	7	7.5	5.5 mm.
Smaller, ,,	6.5	7	5.5 ,,
Height of shell,	7	7.3	5.5 ,,
Spiral angle,	72°	74°	76°

I have not seen from any part of Bengal specimens larger than 8 mm. in the greater diameter, and those from the Western Ghats appear rarely to attain more than 6 mm. in the same diameter. The spiral angle varies in Bengal specimens from 65°—78°, on the average it is decidedly smaller than in *attegia* and may be taken at 74°.

Conulema liricineta, Stol., pl. xviii, fig. 10.

Con. testa late conica, tenui, castanea, apice pallida, vel omnino pallide lutescente, anguste umbilicata; anfractibus 7, convexe gradatis, sutura impressa simplici junctis, quatuor liris acutis spiralibus cinctis: liris duabus medianis crassissimis, superna tenuissima; basi lævigata, prope peripheriam liris 3—4 tenuibus, approximatis notata; lineis incrementi subtilissimis et confertissimis; apertura sub-semilunari, labio columellari rectiusculo, brevi, supra paulo reflexo; labro tenui, simplici arcuato; diam. maj. 6.4, d. min. 6; alt. testæ 5.8, alt. apert. 2.5, lat. ap. 3 mm.

Hab. Prope Moulmein, ad flumen Ataran.

The species has the general form of a rather large and elevated *Con. palmira*, Bens., but the spiral ribs are more distant and stronger, except at the periphery which is less sharply carinated. I have not seen the animal, but judging from the general resem-

blance of the shell to that of *infula*, it is tolerably certain that both belong to one and the same genus.

Genus. SESARA, Albers.

Heliceen, edit. 2nd, p. 91, (see pl. xvi, fig. 4—10).

W. Blanford has already pointed out* the correct classification of this genus in the ZONITIDÆ, Albers having placed it as a subgenus of *Helix*. The type of the genus is *Helix infrendens*, Gould. It represents a group of small, lentiform ZONITIDÆ, composed of numerous whorls, transversely ribbed above and smooth below, generally imperforate, with a thickened columellar lip and a small aperture, being very often contracted by variously shaped teeth or ribs on the outer, or on the inner, lip, or on both of them. Young shells are very similar to those of *Rotula*, but can generally be distinguished by the thickened columellar lip.

I have examined the animal of *S. infrendens* and *pylaica*. Both are quite similar. The foot is very long, narrow, with the terminal gland distinct and a small, hook-like, pointed appendage above it. The sole has two longitudinal grooves, rather close together, the median portion being narrower than each of the outer parts. The mantle edge is nearly entire, the left shell-lobe is below internally considerably thickened, the left dorsal lobe is very small, or almost obsolete; the right shell-lobe is thin and somewhat convex, but without any separate appendage. The internal anatomy does not differ from that of *Rotula* and other ZONITIDÆ, but there is some peculiarity to be noticed in the arrangement of the genital organs.

I have dissected a young and an old specimen of *S. infrendens*. In the young I found, (see pl. xvi, fig. 4), a simple, rather thin uterus and a tube leading from the end of it to the penis, which had a long appendage.

In the old specimen (see pl. xvi, fig. 5,) the uterus, prostata, albuminous and hermaphrodite glands are of the usual form, but in the place where the *receptaculum seminis* should be situated I found a long, twisted, thin sac, partially divided in the lower part. This muscular sac contained three horny, curved tubes, (fig. 6), twisted

* Ann. and Mag. Nat. Hist., 3rd ser., 1863, xi, p. 84.

on the convex side, and provided with ramified appendages. Two of these tubes, terminated with a kind of leathery, white bags, each being provided at the end with a long horny flagellum, the third had none, but it may have been broken off. These leathery bags, together with the end retractor of the penis, were originally located at the end of the prostata (n in fig. 5). Between these horny tubes there was twisted a very long thread (fig. 7,) bearded in its entire length, and apparently consisting of a transparent, glassy substance. Of the same substance a few other simple threads were also observed (fig. 8).

The horny tubes are all hollow and apparently filled with a granular substance, of which, however, the terminal bags contained only a small quantity.

I can form at present no correct idea what the physiological and morphological value of this very singular and most complicated appendage is. Possibly it may in some form or other replace the seminal receptacle, or the arrow sac, for appendages containing similar horny tubes also occur in other ZONITIDÆ, (see p. 249), and in these a special seminal receptacle is also not developed. Examinations of living specimens, must, however, be made, in order to ascertain the true physiological facts.

The seminal duct has a long appendage enclosing a thin flagellum; next to it it is enlarged into a calciferous gland, the calcareous bodies being of a broadly ovate form, acuminate at either end; enlarged to 150 diameters they are seen only as the finest sand. The lower portion of the penis is rather muscular; towards the end it is strongly twisted.

The jaw is semilunar, rather narrow, smooth, finely radiately striated on the inner side and besides marked with very minute striae of growth; it possesses an obtuse projection in the middle of the front edge.

The radula is large, composed of about 60 transverse series of teeth, arranged in almost perfectly straight lines. The central tooth has a single median rather abruptly contracted cusp, laterally it is only slightly flexuous, but not distinctly denticulate; it is somewhat smaller than either of the adjoining teeth. Ten teeth in each row on either side of the central tooth are conspicuously larger

than the following outer ones, which vary between 45 and 50, giving the following formula $50 + 10 - 1 - 10 + 50$. On the inner lateral teeth the median cusps are very long, pointed and hooked; the outer dentical is small and the inner almost obsolete. The outer lateral teeth become very rapidly bicuspid and narrow.

The examination of other species of this genus must shew which of the characters are to be regarded as particularly distinctive in comparison with allied forms. The small size of the centre tooth may be a useful character; but the chief difference probably lies in the genital organs which are quite peculiar, and require further explanation and comparison.

The typical species of *Sesara* are all from the limestone hills about Moulmein. They are *infrendens*, Gould, *pylaica*, Benson, *Tickelli* and *Attaranensis*, Theob. Three other species, *helicifera*, *Basseinensis* and *mammillaris* of Blanford are very probably also referable to the genus; they differ from the typical forms by possessing a thin simple outer lip. All three are also from the Burmese province.

SESARA INFRENDENS, (Gould.)

Helix infrendens, Gould, Bost. Journ., 1844, vol. iv, p. 453, pl. xxiv, fig. 6.—Hanley and Theob., Conch. Ind., pl. xv, fig. 2,—*eadem* auctorum.

Helix capessens, Benson, Ann. and Mag. Nat. Hist. 1856, vol. xviii, p. 250;—*eadem* auctorum.

There can be no doubt that the two forms, described by different authors under the above headings, are identical as to species. Neither Benson nor Pfeiffer could have compared Gould's original figure, otherwise they could not have mistaken the identity of the two species. Theobald's *Tickelli*, (Journ. Asiat. Soc. Beng., 1859, xxviii, p. 306; *eadem*, Pfeiffer; Hanley and Theob., Conch. Icon., pl. xv, fig. 3), appears to differ from it merely by a sharp peripheral keel.* Usually the two outer teeth of the basal outer lip are much closer together, than they themselves are with respect to the inner tooth of the lip. The former always have a common base, which becomes especially apparent when viewed from the internal side. It is extremely rare to find a

* Comp. W. T. Blanford in Ann. Mag. Nat. Hist. 3rd ser. 1863, xi, p. 84.

specimen in which the two outer teeth are as far distant as represented in Gould's or Reeve's figures; Chemnitz's figure is in this respect more correct. A comparatively very rare case is that the two outer teeth on the lip remain almost undeveloped even in full grown shells, but I have collected such specimens. In *Tickelli* the two outer teeth appear to be still closer together than they are usually seen in *infrendens*. The height of the shell of the latter species varies considerably, from nearly one-half to two-thirds of the longer diameter, and the last whorl becomes occasionally somewhat distorted. The largest specimen collected on the limestone hills at Damotha, near Moulmein measures: long. diam. 10·5, shorter diam. 9·7; height of spire 5·2; height of shell 6·5 mm. The corresponding measurements of one of the flattest full grown varieties are 9, 8·4, 4, 5·2 mm., and those of one of the highest forms 9, 8·8, 5, 6·2 mm.

The animal is pinkish white with gray pedicles and somewhat paler tentacles; sometimes the whole of the anterior body and the terminal part of the foot about the tail gland are leaden gray; the mantle is thick at the edge, sometimes white, but more usually pale orange with white minute specks.

SESARA PYLAICA, (Bens.)

Helix pylaica, Benson, A. and M. Nat. Hist. 1856, vol. xviii, p. 249; Conch. Ind., pl xv, p. 2.

The internal thickening of the basal portion of the outer lip generally terminates abruptly near the periphery, occasionally forming a very distinct blunt tooth.

This species does not grow to an equally large size as the last and generally also remains somewhat flatter; the largest specimen measures larger diam. 9·5, shorter diam. 9, axis 4·3, height of shell 5·2 mm.; the corresponding measurements of one of the most elevated specimens are 9, 8·5, 4·8, 5·6 mm.

The animal is pinkish white, darker in front on the back and on the pedicles, as is also the last species; pedicles moderately long, tentacles rather short and paler gray; foot very narrow and long.

Hab. "Farm caves" near Moulmein; common.

Genus. MACROCHLAMYS, BENSON.

Semper speaks (Reisen im Arch. der Philipp., III, pt. I, p. 17) of the receipt of "numerous specimens from Calcutta through Dr. Anderson" of *Macrochlamys splendens*, Hutton. This species was described from Máhasú, near Simla, where I also collected it some years ago. The shell has the outer lip internally thickened, a character which is peculiar only to hill species and is, I believe, chiefly the result of the testaceous, false, operculum not having been entirely absorbed after hibernation. It is by no means a constant character. *H. splendens* does not occur in or about Calcutta, nor anywhere in the plains, as far as I have been able to ascertain, but I found it, or a very closely allied form, at Missouri and at Nynetel in the Himalayas. Dr. Anderson, as I have ascertained from himself, had not received any animals of the species in question from the N. West Himalayas, but those he sent to Dr. Semper were from Darjeeling, where a species, closely allied to Hutton's *H. splendens*, is very common, and, if not full grown, is very similar to a shell which is by Indian conchologists usually called *H. vitrinoides*, Desh.

There occur two allied forms of the *vitrinoides* type about Calcutta: one very flat, with the base conspicuously concave about the umbilicus; it is very closely allied to *M. lubrica*, Bens. The other is a little higher and is said to be *vitrinoides*, Desh. Both are thin shells, the former appears to have no trace of spiral striation; in the other the striæ become traceable when the superficial glossy polish is weathered off, but even then they are not nearly so strongly marked as in *splendens*. Neither of these Calcutta species agrees sufficiently with the original description of Deshayé's *Helix vitrinoides*, but there have been so many other allied species — *pedina*, *decussata*, *sequax*, *resplendens*, &c., and lately one or two by Semper and Martens—described, that it would be unsafe to augment the already confused literature with new names without previously most carefully comparing all the allied forms. Among all the Indian ZONITIDÆ the species of the *vitrinoides* type are certainly the most difficult of discrimination.

With reference to the name *Macrochlamys* itself, I would only observe that it is not correct, when Dr. Semper questions the generic determination of the Bengal *H. vitrinoides*, Desh., as a

Macrochlamys (setting aside for the present the question whether what is usually called *vitrinoides* be really that species or not). When Mr. Benson first mentioned the name *Macrochlamys* in Journal Asiatic Society, 1832, vol. I, p. 13, no one was able to assign a signification to the name; it was mentioned only *passim*. On p. 76 of the same volume, Mr. Benson quotes a *Macrochlamys indicu**, and from the reference on pp. 350 and 351† in vol. V, of the same Journal (1836) it is, I think, tolerably clear that under the above name the Bengal species, usually recorded as *vitrinoides*, was meant. Consequently this species must be taken as the type of *Macrochlamys*, whether it be called *vitrinoides*, or *indicus*, for both, if different, are no doubt very closely allied. Gray quoted‡ *vitrinoides*, Desh., as one of the species of his newly proposed genus *Nanina*, but the name, having been previously generically used by Risso, cannot be adopted.

From Mr. Benson's own record§ we know that a landshell called *Tanychlamys* is identical with *Nanina*, but only in 1836, (vide note) are we informed that *Tanychlamys* is the same thing as *Macrochlamys*, and that the Bengal *vitrinoides*, Desh., is the type of the genus. Thus there is no reason to be given why the latter generic name should be superseded by the former.

I have given the historical record in order to shew, that *Macrochlamys*, if at all adopted as a generic denomination, must be used for the group of which the so-called Bengal *vitrinoides* (or rather *M. indicus*, Benson,) is the type, for if we do not acknowledge it for that type, the name would lose all claim to priority. Albers (*Heliceen*, 2nd edit. p. 57) distinctly quotes *H. (Nanina) vitrinoides*, Desh., as the type of his genus *Orobia*, but Dr. Semper (loc. cit. p. 18) again appears to ignore that fact, and to retain *Orobia* in some other form. When really correct definitions of genera have to be obtained, there is nothing very objectionable in this course, though it cannot be recommended; but whenever type species of genera are mentioned, changes of those generic significations should be made with particular care.

* This name appears to have been entirely overlooked; it will very likely have to come now into use. *Helix Indica*, Pfr., is a *Rotula*.

† This reference also shows that the subsequently used name *Tanychlamys* was applied to the same shell as was *Macrochlamys*.

‡ Proc. Zool. Soc. Lon. 1834, p. 38.

§ Ibidem, p. 89.

MACROCHLAMYS [DURGELLA] HONESTA, Gould, pl. xvii, figs. 6-14.

Helix honesta, Gould, 1846, Proc. Bost. Soc. Nat. Hist., II, 98, *eadem* auct.

This is, like many other allied forms, an extremely variable species.

Gould's original specimen represents a very flat and apparently young shell. I have a young specimen from Pegu, rather strongly keeled at the periphery, horny, translucent, and with a peripheral rufous band; it exactly agrees with Gould's measurements. The specimen from Pegu figured on plate xvii, figs. 6, 6a, 6b, is a full grown shell of the same type and is identical with the one described by Pfeiffer in Monag. Helicorun, vol. i, p. 57. This variety has the outer lip barely descending at the aperture, but it has the characteristic oblique mouth, as noted by Blanford (Journ. A. S. B., 1865, vol. xxxiv, p. 87).

Another variety occurs in Pegu (see fig. 7, pl. xvii,) which is higher and has the last whorl rather rounded, or barely keeled at the periphery, but the outer lip is not descending. Larger diam. 13, smaller diam. $11\frac{1}{2}$, height 8 mm. The same variety also occurs in Arracan and in the Khasi hills, and appears to represent the Bengal *M. vesicula* and *lecythis*, Benson, of the Rajmahal hills, both when young being almost undistinguishable. Reeve's figure of *honesta*, (Mon. Hel., pl. 84, fig. 452), appears to represent the above noticed variety, but it also could be taken for either of the two last noted species.

A third variety occurs at Moulmein and in Upper Burma. This (see fig 9, pl. xvii,) has the whorls above strongly convex, the last almost evenly rounded at the periphery, and at the aperture the outer lip considerably descending, thus causing its narrow shape. It is a very common shell on all the limestone hills about Moulmein, and very closely resembles externally *Sophina Calias*, except that it wants the umbilical carina and slit. The usual size is 11 or 12 mm.; the largest I observed measures, larger diam. 13.3, smaller 11, height 8 mm. Sometimes specimens are met with which appear to attain a somewhat irregular growth after a certain age (see fig. 8, pl. xvii,) ; the additional portion (*a b*) of the whorl being always considerably thinner than the rest of the shell, and

marked with stronger striae of growth. The measurements of the largest specimen of this variety are: larger diam. 13·6, small diam. 12·2, height 9·5 mm.

When fresh, the shell of [*Durgella*] *honesta* is always horny and translucent, the whorls at the sutures adpressed, the surface smooth and polished, except on the last whorl where, near the suture and round the umbilicus, a fine spiral striation is usually observable. The aperture is always oblique, with the upper, or sutural, margin of the outer lip considerably more produced, than the lower or umbilical margin; the inner lip is very thin and the columellar lip at the base distinctly reflected and somewhat thickened, so as almost entirely to cover the umbilicus.

Full grown shells are comparatively solid, especially those occurring on limestone ground, but the young are generally of very thin texture and their aperture also has not the oblique form of the old shell. This makes the former very closely to resemble young specimens of *Macroch. vesicula* or *lecythis*, as has already been noticed.

The animal of the Moulmein variety is narrow, very long, pale white, pedicles and the terminations of the tentacles leaden grey, as well as the upper part of the foot posteriorly; the tail gland is superseded by a very distinct hook; the mantle lobes are well developed, both the upper portions being reflected over the shell. By some accident, however, my spirit specimens were lost and I am, therefore, unable at present to give sufficient details regarding the anatomy of this species. Semper (Reisen in Arch. der Phil., vol. iii, pt. I, 1870, p. 18,) gives some anatomical details of a dried up specimen received through Dr. Anderson, but not, as is stated, from the Andamans. Dr. Anderson had collected his specimens in Upper Burma, when with the Yunan expedition, and some of these specimens he forwarded to Dr. Semper; the species does not occur on the Andaman islands.

I have also examined some of these dried Burmese specimens, and I find the animals agree in external characters exactly with the Moulmein ones. The tail gland is superseded by a very distinct hook; the centre portion of the sole is narrower than the outer portions. The left shell lobe has two linguat appendages, one extending over the peripheral portion of the shell, the other, a

shorter one, over the base; the upper portion of the right shell lobe is linguatè, very narrow and long, the lower short, thick, partially reflected over the lower part of the inner lip. The left dorsal lobe is short and thick above, the right thinner, but larger and extending over the neck.

Semper says that the genital organs of *honesta* are perfectly similar to those of the supposed *splendens*, Hutton, mentioned on p. 246. I have not been able to trace the arrow sac, but there is in full grown specimens a sac connected with the genital system, which contains a peculiar horny, curved, hollow organ (pl. xvii, fig. 13). The anterior end is trumpet shaped, for some distance from that end the sides are provided with various, branched, horny appendages and the whole terminates with a sac, filled with very thin, variously twisted strings, containing intermixed elliptical, transparent, solid bodies. I have not been able to trace in the present species the exact position of this strange organ, but one of a similar kind occurs in *Sesara infrendens*, and in this it is certainly an appendage of the oviduct. The physiological function of the organ itself I am at present unable to indicate.

The jaw is rather narrow, smooth, with the sides slightly curved outward, and with an obtuse median projection in the middle of the front edge; the general form resembles that of *Microcystis*.

The radula is long, composed of about 80 transverse series of teeth; about 23 median teeth in each series being considerably broader than the outer ones, which are on either side about 30 or 35 in number. The centre tooth is symmetrical, tricuspid, the following turn outwards on each side, and the last teeth have two subequal short cusps.

The great development of the lobes of the mantle, and particularly the form of the jaw, the inequality in the teeth and the presence of the peculiar appendage in the genital system indicate distinctions which may be sufficient for separating the present species generically from *Macrochlamys*, and in this case Mr. W. Blanford's name *Durgella* would most probably be applicable to it. This name has been proposed for Benson's *Helix levicula* from Tenasserim, as type, and would indicate a close relation, both in the form of shell and the characters of the animal, to *Helicarion*. Whe-

ther Blanford's *mucosa*, and in that case also *lecythis* and *vesicula* of Benson belong to the same genus or subgenus, I am not at present prepared to affirm.

Genus. MICROCYSTIS, Beck.

(Semper, in Reisen im Arch. der Philipp., III, pt. i, p. 43.)

This genus does not appear to have many representatives in India, unless some of the small species, like *H. Neherensis*, *petasus*, *patane* of Benson &c., should prove to be more related to it, than to *Macrochlamys*, though this is not very probable. A few Himalayan species, like *Hodgsoni*, *rorida*, &c., are, however, probably referable to *Microcystis*.

MICROCYSTIS MOLECULA, Benson, pl. xviii, figs. 11-13.

Helix molecula, Benson, Ann. Mag. N. H., 3rd ser., III, p. 389.

The species is very common about Moulmein, Rangoon and on the Arracan coast, on limestone as well as on sandstone hills, not uncommonly also on foliage. Specimens measuring 4 mm. in the large diameter, and 3 mm. in height, may be considered of large size; those usually met with are somewhat smaller. The largest specimen was obtained at Zwagabin on the Salvín river; it is rather pale brownish green; larger diam. 5.6, smaller diam. 5, height 4.5 mm.; this form approaches *Helix Poongee*, Theob.

The animal is grey, varying in shade, sometimes almost black; foot moderately narrow, paler at the sides; lateral line distinct; sole with two grooves; tail gland distinct, with a hook-like appendage above it; length of the animal 3—4 times the diameter of the shell. The left mantle lobe is reflected over the outer lip, but is not much produced, right mantle lobe above shortly linguatate. The genital organs are quite simple. The uterus has no appendages; it terminates with a long, narrow, albuminous gland, and the hermaphrodite duct is of great length. The *vas deferens* branches off at about the middle length of the uterus; it has a small calciferous sac where it passes into the penis, which is attached by a short muscle, and after a short twist at about the middle of its length enlarges into a muscular, soft, spongy thickening; this enlargement did not contain calcareous particles. No seminal

receptacle, nor an amatorial sac has been observed, though the single specimen examined appeared to be full grown.

The jaw is almost semicircular, very thin, smooth, broad; the terminal corners of the anterior concave edge are somewhat roundly projecting, and the middle part has a very slight tooth.

The radula appears to be comparatively large, but I have not seen it perfect. The teeth are arranged in almost straight, transverse rows, about 120 in each row, the median teeth in each row being conspicuously larger than others. The centre tooth is, as usually, symmetrical, tricuspid, the middle cusp being very long, pointed and curved; the lateral cusps are much smaller and below them there is on each side a second small blunt denticle present. The lateral teeth are turned outwardly on either side, the inner lateral cusp becoming smaller, while the outer slightly increases in size, until on the last laterals it almost equals the principal cusp.

Genus, SOPHINA, Benson.

Ann. and Mag. Nat. Hist., 1859, vol. III, p. 473.

The shells of *Sophina* are characterized by a more or less thickened columellar lip, forming with the basal portion of the outer lip an angle, and producing a ridge round the umbilicus; they are of small or median size, sub-orbicular shape and thin structure.

Three species have been described by Mr. Benson, one of which turns out to be only a variety of another, and I shall now add two new species. All are from the neighbourhood of Moulmein, and are only found on limestone hills. The animals are very similar to each other, and it will suffice to give some details of the type of the genus. All of them can fully retract their bodies in the shells, but sometimes with difficulty as in *Helicarion*, to which *Sophina*, on account of the great development of the mantle lobes, bears a close relation.

The foot of *S. calias* is very elongated, rather narrow, with a very distinct lateral line, marked with oblique furrows above it, nearly smooth below it down to the edge of the sole. The posterior end is obliquely truncate, occupied by a large, high gland and superseded by a distinct horn-like appendage. The sole has two longitudinal grooves, dividing it in three, subequal parts, the inner being somewhat narrower than the outer parts; the grooves are usually well

traceable on spirit specimens, but during life they are not equally easily discernible. Pedicles about half the length of the body, tentacles about one-fourth of the length of the pedicles, both with swollen tips. Mantle conspicuously thickened near the margin, its external edge very short, entire and continuous. The left shell lobe is very large, entire, reflected over the edge of the outer lip, and below considerably produced; the right mantle lobe is divided into two parts, the upper is linguata, narrowly produced and covering the base of the shell, partially also extending on to the upper surface of the penultimate whorl, as in *Macrochlamys*; the lower portion is shorter, somewhat folded and reflected over the columellar lip. The dorsal lobes are well developed and entire, the left is a little larger, and both are thickened round the pulmonary orifice; the right considerably extends over the side of the neck. Hermaphrodite opening situated at the upper, somewhat outer, base of the right pedicle. The shell retractor is flattened and considerably thickened, forming sharp angles, above and below, with the body. Its strong development is apparently due chiefly to the circumstance that the animals always crawl on hard rock.

The general anatomical structure offers nothing very particular and will be much better understood by an inspection of figure 1, on pl. xix, and by a comparison of the accompanying explanation, than by a lengthened description. The anterior part of the alimentary canal is comparatively short, the stomach extends over one and a half volutions of the shell, it has no appendages. The last two volutions are entirely occupied by the liver which has the usual paler or darker greenish colour. The hermaphrodite gland is in its original situation placed about the end of the stomach. The kidney (*k*) is an elongated, rather more granular than plicated gland, placed at the side of the heart, it possesses a special long duct (*kd*), accompanying the rectum, and terminating a little short of the anus.

The genital organs (fig. 2, pl. xix,) chiefly occupy the anterior part of the body. The arrow sac is short and thick, with an enclosed thick, pointed papilla. The uterus, accompanied by the prostata, is very long, thick, the former has a yellowish colour with a greenish tinge, the latter is purely white; terminal albumin-

ous gland (*ag*) of moderate size, slightly thickened; hermaphrodite gland (*hg*) large, rather flatly depressed, connected with the uterus by a long twisted duct (*hd*). The vas deferens (*vd*) branches off a short distance from the hermaphrodite opening; in about three-fifths of its length from its origin it has a long pointed appendage (*ep*), consisting of strong tissue, filled with minute, elliptical, calcareous secretions; this appendage is attached by a special muscle close to the place of attachment of the arrow sac; the last two-fifths of the vas deferens gradually widens, and towards the end the simple tube consists internally of remarkably soft, muscular tissue, but there is no papilla present. The receptaculum seminis (*rs.*) is a globular gland, attached to a long, slightly twisted string, originating from the oviduct, quite close to the hermaphrodite opening.

I may here record an observation, which I have repeatedly made *viz.*, that there is a very great difficulty in tracing spermatozoa in the hermaphrodite gland. Eggs are certainly formed there, but they further develop to an appreciable size in the uterus, into which the necessary amount of albumen is supplied from the albuminous gland. Spermatozoa I could not, in this case, detect in the hermaphrodite gland; they must be of extreme minuteness, but they become fully developed in the hermaphrodite duct or string (*hd*); in fact this duct almost entirely consists of spermatozoa in nearly all terrestrial Mollusca which I have examined.

The jaw of *S. calias* is broadly semilunar, thin, apparently smooth, but when moderately enlarged and viewed in transparent light, a distinct concentric striation is perceptible and there are also some very minute radiating lines to be observed near the middle part. A fringe of muscular tissue is attached to the convex side, the concave margin is usually entire, but in one instance (see pl. xix, fig. 3 *a*), I observed a very distinctly developed projection in the middle; this example is taken from the var. *schistos-telis*, but other specimens of the same variety, and equally large, did not possess it. The jaws of *S. discoidalis* and *conjungens* are similar to those of *calias*, only differing very slightly in shape; in both there is a small projection at the centre of the concave margin, and both are also finely concentrically striated, like the jaw of *S. calias*.

The radula is elongately quadrangular, consisting of about 35 to 50 transverse rows of teeth, meeting at sharp angles in the middle line; there are about 80—100 teeth in each row. They are all of a similar shape, pyramidal, sharply pointed and attenuated in front, gradually becoming wider and terminating with an obtusely rounded base. The middle tooth is slightly contracted below the middle, it is symmetrical; the laterals are gradually more bent outwards on either side and possess on the outer side near the point, a rounded and angular projection; the angle appears to be directed posteriorly; the outermost teeth are quite simple.

The teeth of *S. discoidalis* and *conjungens* are exactly similar to those of *calias*, only comparatively smaller. The jaw and radula of *S. forabilis* were not examined.

SOPHINA CALIAS, Bens., pl. xix, figs. 1—4 and 7—9.

Ann. Mag. Nat. Hist., 3rd ser, III, p. 473,—*eadem*, Pfeiffer, Mon. Hel., vol. v, p. 111 and 112.

Syn. *Sophina schistostelis*, Bens.

Soph. testa sub-globosa vel orbiculato depressa, solidula, pallide cornea, polita; anfractibus $4\frac{1}{2}$ — $5\frac{1}{2}$, convexiusculis, sutura continua adpressa sejunctis; striis incrementi minutis, confertissimis, infra suturam levissime canaliculatis et striis spiralibus nonnullis notatis; anf. ult. ad peripheriam rotundato, ad basin leviter convexo, modice umbilicato: umbilico circa duodecimam partem diamet. maj. testæ æquante, profundo, carinâ crassiusculâ circumdato; apertura rotundate et depressiuscule semilunari, labio adnato crassiusculo, albo, ample expanso; columella crassa, valde obliqua, conspicuiter, precipue ad basin, dilatate reflexa, in aspectu frontali umbilicum fere omnino tegente, rugulata, ad medium subdenticulata; labro simplici, intus paululum incrassato, ad marginem obtusiusculo, supra ad suturam producto, infra margine basali levissime curvato; carina umbilicali profunde et angustissime incisa. Diam. maj. spec. maximi 13·5; d. min. 11·8; axis 7·6 mm.; altitudo 8·5; alt. apert. 6·1, lat. ap. 6·4 mm.

Var. *schistostelis*, (fig. 8) testa ultimo anfractu multo majore, tenui, pellucido; apertura semilunari, marginibus tenuissimis: labro

columellari modice obliquo, levi, supra reflexo, labro supra paulo flexuose producto, ad basin fere recto; carina umbilicali distincta, tenui, ad aperturam paulo incisa. Diam. maj. spec. max. 17 mm.; diam. min. 14.5; axis 8.5; alt. testæ 11, alt. apert. 8, lat. apert. 9 mm.

The species offers a remarkable instance of variation during different stages of growth. As the type, I consider the smaller form with a solid shell, the columellar lip very oblique and rugose, the outer lip obtuse and internally slightly thickened, and the umbilical ridge with a deep incision. This type is represented in fig. 7, on plate xix. Small specimens, measuring only 5 mill. in the larger diam., occur of exactly the same form; it seems, therefore, that they often attain maturity at an early stage.

Very commonly, however, it is the case that the shells grow further, after they have attained that certain stage of maturity. The increase amounts from one-third sometimes to one and a half circuit of a whorl, as indicated in the figure 8 *b*. This additional portion of the shell is always thinner than the rest, and more transparent, the outer lip of the aperture is at the suture less produced on to the penultimate whorl, the columellar lip less oblique, thin, smooth, and the umbilical ridge is only slightly incised. In this stage, the species was described by Benson as *Soph. schistostelis*, and it is certainly a most marked variety. There can, however, be no doubt that it is only an abnormal growth, for when the terminal half of the last whorl, indicated in fig. 8 *b*, is broken away, a typical *Soph. calias* of the shape, represented in fig. 7, 7*a*, 7*b*, can be obtained.

There appears to be no rule as to the size of the shell at which the abnormal growth begins, (or in other words at which a *S. calias* is changing into a *S. schistostelis*), but the latter is locally so constant, that very few specimens stop growth at the normal stage, while the abnormal forms are met with in thousands. It is really difficult to decide in such cases, whether we ought to call these abnormal forms distinct species or not. But the fact clearly shews, how species are developed, one out of the other. In this special case no one will doubt the propriety of regarding the larger form as an abnormal growth of the smaller one, because the original type can still be traced. But supposing

the peristome of the normal shell had been entirely absorbed, and then the growth proceeded as usually; in such a case it would be much more difficult, and sometimes quite impossible, to trace the connection of the two forms, which could then with more propriety be acknowledged as two distinct species.

When after hibernation the calcareous covering or false operculum of the aperture has not been perfectly dissolved, the inner peristome becomes sometimes irregularly thickened, as if it had been injured, (fig. 9 of pl. xix,) and then imperfectly restored.

The animal is whitish or pale fleshy gray, slightly darker on the head, and on the pedicles and tentacles; mantle white in young, grey near the edge in older, specimens; posterior end of foot often tinged gray.

Hab. The species is very common on the limestone hills to the east and south of Moulmein.

SOPHINA FORABILIS, Bens., pl. xix, fig. 10.

Ann. Mag. Nat. Hist., 3rd ser. vol. iii, p. 389;—*eadem*, Pfeiffer, Mon, Hel., vol. v, p. 112.

Soph. testa depressiuscule semiglobosa, parva, tenui, cornea, nitida; anfractibus 5—5½, convexiusculis, sutura adpressa, vix canaliculata, junctis, striis incrementi filiformibus confertissimis et in anf. superioribus striis spiralibus, aut subtilissimis aut fere omnino obsolete, tectis; ult. anf. ad ambitum rotundato, ad basin leviter convexiusculo, perforato; umbilico latiusculo 0·16 partem long. diam. maj. æquante, carinâ distinctâ, albidâ circumdato, ejusque lateribus interioribus verticaliter descendentes; apertura rotundate semilunari, labio albido, tenuissimo, breviter expanso; columella prolongata, paulo incrassata, recta, fere verticali seu paulo obliqua, ad basin breviter reflexa; labro tenui, fere recto, supra vix flexuoso et paululum producto, infra leviter convexo et cum columella angulum circa 115° formante; emarginatione carinæ umbilicalis brevi. Speciminis max. diam. maj. 8·8 mm.; min. 7·5; axis 5; alt., 5·8; alt. apert. 3·8; lat. ap. 4 mm.

This species may be regarded as the diminutive of the variety *Soph. schistostelis*, but it is readily distinguished from it by its less convex base and comparatively large umbilicus; it never seems to

grow to a large size, and is always of a horny brown colour, with the umbilical carina often white.

The animal is dull white, with grayish pedicles and tentacles, foot very narrow, the glandular appendage not very prominent.

Hab. I only found *forabilis* on the limestone hills at Damotha near Moulmein, where no other species of *Sophina* occurred.

Sophina discoidalis, n. sp., pl. xix, figs. 5, 11, 12.

Soph. testa depressa, subdiscoidea, tenui, pallide cornea, pellucida, cornea, nonnunquam circa peripheriam faciâ castaneâ notata; anfractibus 5—5½, convexiusculis, striis incrementi subtilissimis notatis, suturâ adpressâ, leviter canaliculatâ disjunctis, et infra suturam lineis spirâlibus impressis et paucis notatis; apice paululum prominente; anf. ult. ad ambitum compressiusecule rotundato, ad basin levissime convexiusculo, prope medium paulo depresso et perforato: umbilico amplo, 0·15 partem diam. maj. long. æquante, carinâ perdistinctâ, filiformi, circumdato; apertura depresso semilunari, marginibus tenuibus instructa: labio parietali adnato tenuissimo, columellari brevi, crassiusculo, obliquo, ad basin conspicuiter reflexo, ad carinam recurvato; labro tenui, fere recto, supra peripheriam paululum producto; carina umbilicali modice incisa. Speciminis max. diamet. maj. 10·5 mm.; min. 9; axis 4·5; alt. 5·5; alt. apert. 4·4; lat. ap. 4·7 mm.

Hab. On the limestone hills of the so-called 'Farm Caves,' on the Ataran river and also on similar hills south of Moulmein.

The depressed shape of this species, together with a comparatively large and strongly carinated umbilicus, readily distinguish it from other *Sophinae*. The specimens which I collected at the Farm Caves and south of Moulmein are all of a uniform pale straw colour, but I have lately received from Mr. Theobald a few which were obtained further eastwards on the Ataran river, and these possess a very distinct brown band above the periphery of the last whorl (see pl. xix, fig. 12); there is, however, no other specific difference between the two.

Animal pale yellowish or brownish white, posterior end of the foot about the gland generally tinged with gray.

Sophina conjungens, n. sp., pl. xix, fig. 6, 13.

Soph. testa semigloboso orbiculata, tenui, semipellucida, cornea, in speciminibus junioribus fere hyalina; anfractibus 5—5½, convexiusculis, suturis adpressis vix canaliculatis sejunctis, striis incrementi tenuibus et alteris spiralibus subtilissimis tectis, nonnunquam albide strigatis seu fasciatis; anf. ult. ad peripheriam rotundato, ad basin leviter convexo, modice umbilicato: umbilico 0·13 part. diam. maj. long. æquante, carinâ obtusâ indistinctâ, nonnunquam fere obsoletâ, circumdato; apertura semilunari, marginibus tenuissimis instructa: labio adnato expansiuseculo, columellari vix incrassato, obliquo, ad basin paulo reflexo; labro fere recto; emarginatione umbilicali minima. Speciminis max. diamet. maj. 11·6 mm.; minor 10; axis, 6·2; alt. 7·2; alt. apert. 5·3; lat. ap. 5·6 mm.

Hab. South of Moulmein.

This species represents in some respects a connecting link between *Macrochlamys* (particularly the subgenus *Durgella*) and *Sophina*, the umbilical carina being sometimes nearly obsolete, but it is always indicated by an obtuse angle accompanied below by a slight furrow and by a small emargination at the peristome. The shell when young is almost diaphanous, and very thin; older specimens become partially opaque, especially near the sutures. The thin horny, transversely finely striated cuticle is sometimes interrupted by white spiral striæ or bands on the whole surface, or only below; near the umbilical edge the striæ of growth are generally also more distinctly marked than elsewhere.

The animal is greenish white, somewhat darker about the head, but in no respect different from that of other *Sophina*.

PLATE XV.

Figs. 1—3. *Plectopylis achatina*, Gray, p. 217 et seq.

1, general anatomy; 2, jaw; 3, different teeth of one transverse series.

Figs. 4—6. *Plect. cyclaspis*, Benson, p. 217 et seq.

4, genital organs; 5, jaw; 6, various teeth of a series.

ft., foot; *a*, anus; *l*, lungs; *mt*, mantle; *rm*, retractile muscle of the foot; *p*, penis; *oe*, oral parts; *sg*, salivary glands; *roe*, retractor of the oral parts; *m*, retractor of the penis; *sgl*, supposed arrow gland; *al*, alimentary canal; *rs*, seminal receptacle; *li*, liver; *alg*, albuminous gland; *hd*, hermaphrodite duct; *hg*, hermapt. gland; *i*, intestines; *st*, stomach; *k*, kidney; *h*, heart; *pg*, pigment gland; *vd*, vas deferens; *ut*, uterus; *eg*, eggs in the uterus; *pr*, prostata, *ho*, hermaphrodite opening.

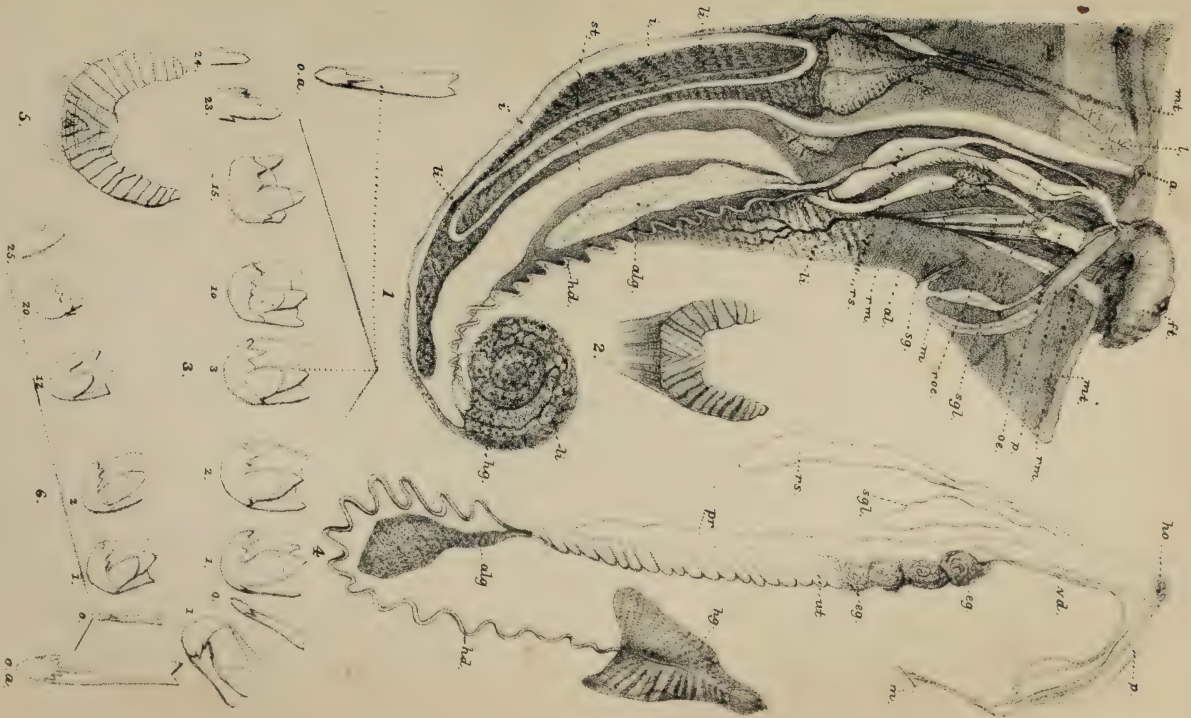


PLATE XVI.

Figs. 1—3. *Trachia delibrata*, Benson, p. 225.

1, genital organs ; 2, jaw ; 3, various teeth of one transverse series.

Figs. 4—10. *Sesara infrendens*, Gould, p. 242 et seq.

4, genital organs of a young specimen ; 5, the same of a full grown specimen ; 6, horny organ situated in an appendage of the oviduct, enlarged ten times the natural size ; 7, a transparent, horny, bearded thread, connected with the appendage represented in fig. 6 ; 8, similar threads, as seen in fig. 7, but not bearded ; 9, jaw ; 10, different teeth of one transverse row.

ho, hermaphrodite opening ; *p*, penis ; *m*, retractor muscle ; *ut*, uterus ; *rs*, seminal receptacle ; *hd*, hermaph. duct ; *alg*, albuminous gland ; *vd*, seminal duct ; *c*, calciferous sac ; *f*, flagellum ; *o* upper and *o'*, lower end of the peculiar horny appendage of the oviduct ; *n*, place where the end of the horny appendage was originally situated.

PLATE XVII.

Figs. 1—5. *Rotula anceps*, Gould, see p. 233 et seq.

1. General anatomy, 2, diagrammatic view of the various lobes of the mantle, enlarged; 3, genital organs; 4, jaw; 5, teeth, all enlarged (see p. 236).

Figs. 6—14. *Macrochlamys* [*Durgella*] *honesta*, Gould, p. 248 et seq.

6, normal form; 7, Pegu variety; 8, abnormal variety from Moulmein, (comp. p. 248); 9, variety from near Moulmein; 10, jaw; 11, peculiar solid, horny threads from the genital organs; 12, solid particles out of the bag marked *x* in fig. 13, which is a peculiar appendage of the genital organs; 14, various teeth; all objects represented in figures 10—14 are greatly enlarged.

f, foot; *fg*, foot gland; *a*, anus; *r*, rectum; *ag*, amatorial gland; *al*, albuminous gland accompanying the rectum; *li*, liver; *i*, intestines; *st*, stomach; *sg*, salivary glands; *h*, heart; *k*, kidney; *pg*, pigment gland; *l*, lungs; *oe*, oral parts; *lsl*, left shell lobe of mantle; *lsl'*, lower end of the same; *rsl*, right shell lobe; *rsl'*, lower end of the same; *rdl*, right dorsal lobe; *ldl*, left dorsal lobe; *p*, penis; *p'*, enlarged portion of the same; *cd*, calciferous gland; *fl*, flagellum; *vd*, vas deferens; *fa*, sessile gland of the oviduct; *rs*, receptaculum seminis; *ut*, uterus; *pr*, prostata; *hd*, hermaphrodite duct; *hg*, hermaphrodite gland; *alg*, albuminous gland; *m*, retractile muscle; *ho*, hermaphrodite opening.

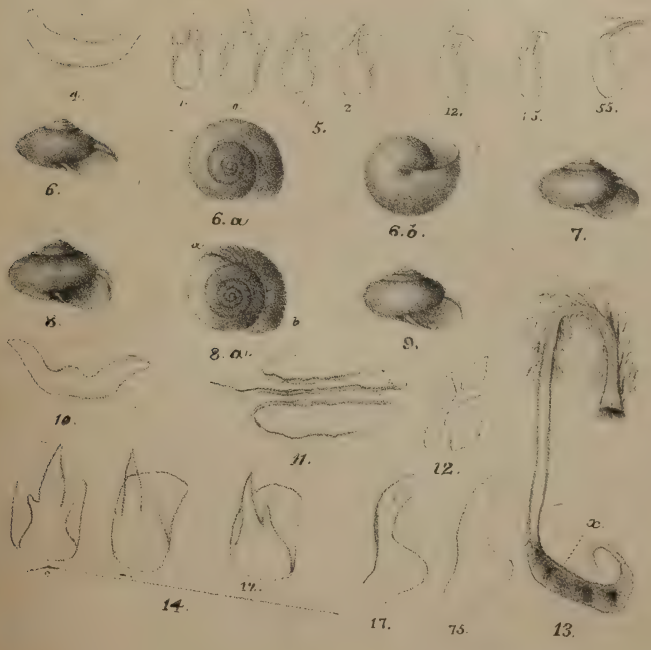


PLATE XVIII.

Fig. 1—4. *Conulema attegaia*, Benson, p. 237.

1, genital organs; 1*a*, section of the amatorial gland; 2, diagrammatic view of the mantle lobes; 3, jaw; 4, different teeth of one transverse series.

Figs. 5—9. *Conulema infula*, Benson, p. 239.

5, side view of an animal, from Calcutta; 6, genital organs during the winter season; 7, anterior portion of the same during the rainy season; 8, jaw; 9 various teeth of one transverse series.

Fig. 10, *Conulema liricineta*, Stol., p. 241.

Figs. 11—13. *Microcystis molecula*, Benson, p. 251.

11, genital organs; 12, jaw; 13, a few teeth from a transverse series.

ag, amatorial gland; *ho*, hermaphrodite opening; *m*, retractor muscle; *p*, penis; *ps*, calciferous sac; *vd*, vas deferens; *pr*, prostata; *ut*, uterus; *hd*, hermaphrodite duct; *hg*, heramph. gland; *alg*, abbuminous gland; *rs*, receptaculum seminis; *ov*, enlarged ovary sac; *rsl*, right shell lobe of the mantle; *rsl'*, lower end of the same; *lsl*, left shell lobe; *lsl'*, lower end of the same; *rdl*, right dorsal lobe; *ldl*, left dorsal lobe; *α*, *β*, *γ*, *δ*, successive layers in the section of the amatorial gland, (fig. 1*a*).

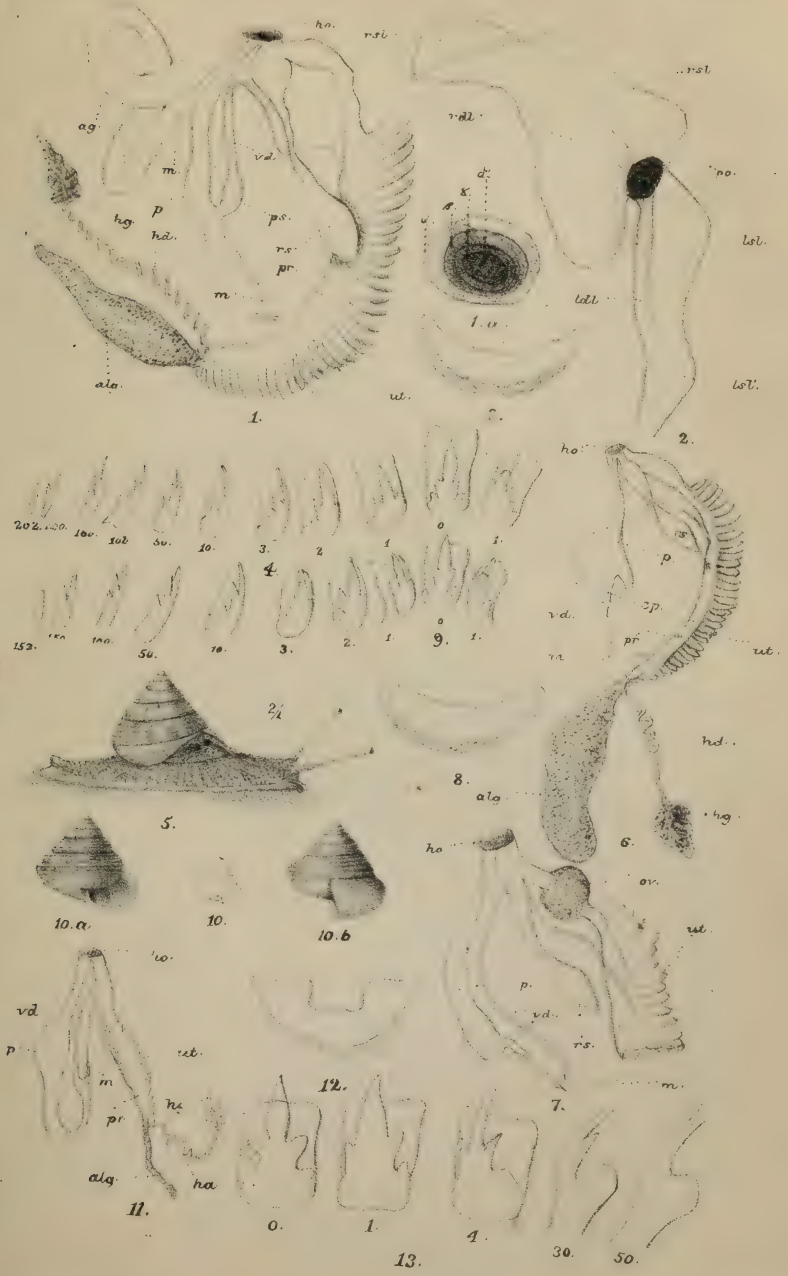


PLATE XIX.

Figs. 1—4 and 7—9. *Sophina calias*, Benson, p. 255.

1, general anatomy; 2, genital organs; 3, 3a, jaws; 4, a few teeth of a transverse series, the 5th and 14th tooth shewn in a lateral view; 7, typical specimen, front, side and upper views; 8, var. *schistostelis*, same views; 9, a specimen with irregularly thickened peristome.

Fig. 10. *Sophina forabilis*, Benson, p. 257.

10a, the front view, is enlarged twice the natural size.

Figs. 5, 11, 12, *Sophina discoidalis*, Stol., p. 258.

5, jaw; 11, a much depressed specimen, natural size; 12, a somewhat elevated specimen; figs. 12a, 12b, 12c, are enlarged.

Figs. 6 and 13. *Sophina conjungens*, Stol., p. 259.

6, jaw; 13, different views in natural size.

oe, oral parts; t, tentacles; ep, eye-pedicles; a, anus; kd, kidney duct; mt, mantle; lml, left shell lobe; rml, right shell lobe; sg, salivary glands; n, ganglion; ao, aorta with the branches lh and bg; st, stomach; k, kidney; h, heart; l, lungs; r, rectum; m, retractor; cp, calciferous sac; vd, seminal duct; rs, seminal receptacle; p, penis; gs, amatorial gland; ho, hermaphrodite opening; pr, prostata; ut, uterus; hd, hermaphrodite duct; hg, hermaphrodite gland; ag, albuminous gland.

